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The Effect of CNATRA Student Production Goals on Required Manning Levels in Helicopter Training Squadron EIGHT

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EMBA PROJECT REPORT

The Effect of CNATRA Student Production Goals on Required Manning Levels in Helicopter Training Squadron EIGHT

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EXECUTIVE SUMMARY

Military units are continually expected to do more with less. This is especially true in the Naval Aviation Training Commands. Military forces are globally committed *now*, while training commands are producing a product for the *future*. As such, both the operationally committed forces and the Shore Training Commands need experienced Fleet Aviators. Practically, however, Operational Commanders get priority and Training Commands are forced to provide qualified officers to fill compulsory Individual Augment (IA) billets. Eventually, this policy of 'robbing Peter to pay Paul' will adversely impact the flow of newly qualified officers to back-fill the Fleet. The objective of this study is to determine a realistic manning level for a single squadron in the Naval Aviation Training Command and use that information to provide leadership with a quick-estimate manning ratio of students to instructors. This ratio will allow leadership to quickly estimate potential production shortfalls if student requirements change unexpectedly.

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I. INTRODUCTION AND BACKGROUND

A. INTRODUCTION

While operational missions are critical now, the Aviation Training Command product (i.e., new pilots) is critical to the continued success of operational units. The Chief of Naval Aviation Training (CNATRA) recently raised the requirement for new pilot output by 15% (CNATRA, 2007), while instructor manning levels have remained constant. At what manning level will the supply of Instructor Pilots (IP) be insufficient to meet the demand for CNATRA's student production goal? This study examines the impact of increasing student production goals without a proportional increase in IP manning levels in Helicopter Training Squadron EIGHT (HT-8).

B. BACKGROUND

Naval Aviation Training Commands serve as shore duty assignments for Instructor Pilots. Traditionally, the missions of shore duty commands complement and enable the missions of operationally deployed units. In the current military environment (GWOT, cost-wise readiness, BRAC, "right sizing" of forces, etc.), shore personnel with Fleet experience (i.e., instructors) are routinely selected to fill compulsory IA billets.

With an ever-increasing demand for operational Naval Aviators, the requirement for greater pilot production is also increasing. There is a "whip" effect felt at the training command level when the operational Fleet requires more trained aviators. For example, Fleet Squadrons will pressure the Fleet Replacement Squadrons (FRS) to produce more pilots. The FRS in turn will look toward its supply (i.e., Advanced and Primary Training Squadrons) and apply pressure for more pilots. The end of the whip is felt at Aviation Preflight Indoctrination (API) where demand for potential aviators is increased. In order to meet the demands of the Fleet and factoring in an attrition rate at each training level, the result is a 15% increase in pilot production from FY06 to FY07 (CNATRA, 2007) for HT-8. Due to the requirements of the Operational Fleet, a proportional increase in instructor manning for HT-8 is unavailable. The result is that HT-8 will have to do more with less.

C. PROJECT OBJECTIVES

The objective of this research effort is to provide Training Air Wing FIVE (TW-5) leadership with a realistic estimate of the instructor manning level required to meet annual student production goals.

Specifically:

• *Is HT-8 manned to the appropriate level now?*

• *What is a realistic loading level for available instructor flight time?* Manning a squadron by assuming that 100% of an instructor's flight time will be used for student production is impractical. Manning decisions must take in to account recurring instructor qualifications and operational surge capability to develop an appropriate loading level for available instructor flight time.

• *At what manning level will HT-8's ability to meet the CNATRA student production goal be at risk?* The number of students HT-8 can produce is directly proportional to the number of instructors HT-8 has available for student production. If HT-8's instructor pool is continually drawn from to fill operational billets, eventually HT-8 will not be able to meet production requirements.

• *How do the findings of this analysis compare with the official manning policy for HT-8 (CNATRA manning document)?*

• *Can a manning ratio (instructors to achievable student production) be developed for executive use in forecasting potential shortfalls if student production requirements are changed unexpectedly?*

D. PROJECT SCOPE

The analysis will focus on a single unit (HT-8) in the Naval Air Training Command. The instructor manning level discussed in this analysis refers to the number of instructors that are committed to student production. Unit specific tasking of instructors that does not directly lead to completion of student syllabus flight events must be considered separately by leadership.

The analysis will avoid consideration of unit-level organizational and supporting activity decisions, including:

- Process bottle-necks (choke-points) caused by squadron policy on qualifying Instructor Pilots (IPs) to teach specific training events.
- Squadron-specific limitations on IP and/or student flight time.
- TDY funding levels.
- Aircraft availability.
- Outlying fields’ availability / limitations.
- Airspace / Working area limitations.
- South Whiting (home field) limitations.

Waivers of Naval Aviation governing documents will not be considered. For example, OPNAVINST 3710 allows monthly individual flight hour limitations to be waived by a Commanding Officer after consultation with a Flight Surgeon.

II. METHODOLOGY

The following steps were undertaken to achieve the goals of this research:

- Determine available fly days per instructor per year
- Determine theoretical maximum hours per instructor per year
- Determine programmed student flight time requirements for syllabus completion
- Determine reasonable student flight time requirements for syllabus completion accounting for variability
- Convert reasonable student flight hours to determine yearly demand
- Determine Full Time Equivalent manning level based on student demand and instructor supply

III. RESULTS

• Determine available fly days per instructor per year

Available fly days per instructor per year were calculated to be approximately 140 days. See Appendix A for detailed calculations and explanation.

• Determine theoretical maximum hours per instructor per year

After calculating available fly days per instructor per year, the days were multiplied by the OPNAVINST 3710 daily maximum of 6.5 flight hours. This number was compared to the OPNAVINST 3710 annual maximum of 595 flight hours per instructor. Flight hour waivers were not considered. The lower of the two numbers was then considered to be the maximum annual available instructor flight time. See Appendix A for detailed calculations and explanation.

• Determine programmed student flight time requirements for syllabus completion

The demand for flight time by students for syllabus completion as stated in CNATRAINST 1542.156:

- Advanced Helicopter 66 Events (Estimated 113.6 flight hours)
- Osprey 39 Events (Estimated 60.0 flight hours)
- Flight Surgeon 5 Events (Estimated 8.2 flight hours)

• Determine reasonable student flight time requirements for syllabus completion accounting for variability

The CNATRA student curriculum places a flight hour goal on each student event. Several factors (weather, student ability, airfield congestion) cause instructors to routinely over or under fly the flight hour goal for each event. For this analysis, a Monte Carlo simulation of 1,000 runs was used to estimate a reasonable flight hour total per student while accounting for this variability. The following numbers were generated:

- Advanced Helicopter 117.4 flight hours
- Osprey 66.5 flight hours
- Flight Surgeon 8.0 flight hours

See Appendix B for detailed calculations and explanation.

• Convert reasonable student flight hours to determine yearly demand

- Advanced Helicopter 31,345.8 flight hours
- Osprey 665.0 flight hours
- Flight Surgeon 368.0 flight hours

The total student flight hour requirement for the year is 32,378.8. See Appendix B for detailed calculations and explanation.

• Determine Full Time Equivalent manning level based on student demand and instructor supply

FTE manning level was calculated to be 77.8 for a 70% instructor loading level. See Appendix C for detailed calculations and explanation.

IV. ANALYSIS

A. FLIGHT TIME LIMIT

Instructors are limited by annual flight hours available, not number of days available for training. An initial assumption entering this analysis was that CNATRA does not properly account for the number of days a flight instructor has available for training. As such, an independent method for determining days available for instruction (explained in Methodology) was devised. The team found that (on average) a flight instructor has approximately 140 days available for flying. The team then multiplied 140 days by the OPNAVINST 3710 daily maximum flight time (6.5 hours) to yield 910 annual flight hours per instructor per year. This exceeds the OPNAVINST 3710 maximum annual flight time of 595 flight hours by 53%. As such, instructors are limited primarily by flight time and not by days available for flight training. This study found that the days available for flight training contribute more to instructor morale and ease of scheduling; they are not a limiting factor for purposes of manning decisions.

B. LOADING LIMIT

What is a realistic loading level for available instructor flight time?

Answer: 70% instructor loading level.

In order to answer the first research objective (i.e., to determine whether HT-8 is manned correctly now), loading level results must first be explained. Figure 1 shows a graph of Instructor Pilot (FTE) Manning versus Loading Level on the left axis, with Probability of Waiting shown on the right axis. Probability of Waiting is defined in this study as the probability that a student will not be able to fly because there is not an instructor available on a day when the student otherwise should be flying, i.e., his pre-requisites are complete, weather is good, he is not sick, etc. For example, if Probability of Waiting is 10% and there are 100 students in syllabus, then 10 students will not be scheduled to fly because there are not enough instructors to fly the students. Obviously, the Probability of Waiting should be 0%. This occurs at 70% instructor loading level and corresponds to an instructor pilot FTE of 77.8 instructors. This means that the

Commanding Officer should expect his pilots to devote an average of 416.5 flight hours annually (595 hours x 0.70) to student training. The remaining 178.5 hours are available for instructor proficiency training and recurring qualifications, assuming no unforeseen scheduling conflicts develop. If unexpected, long-term scheduling conflicts develop (such as a hurricane or mishap) then the Commanding Officer maintains a 30% surge capacity with his instructor force to recover lost flight events during the scheduling conflict. If the system were tasked at 100% during "normal" conditions, lost production could never be re-gained if the system encountered a setback of any kind (minor or major).

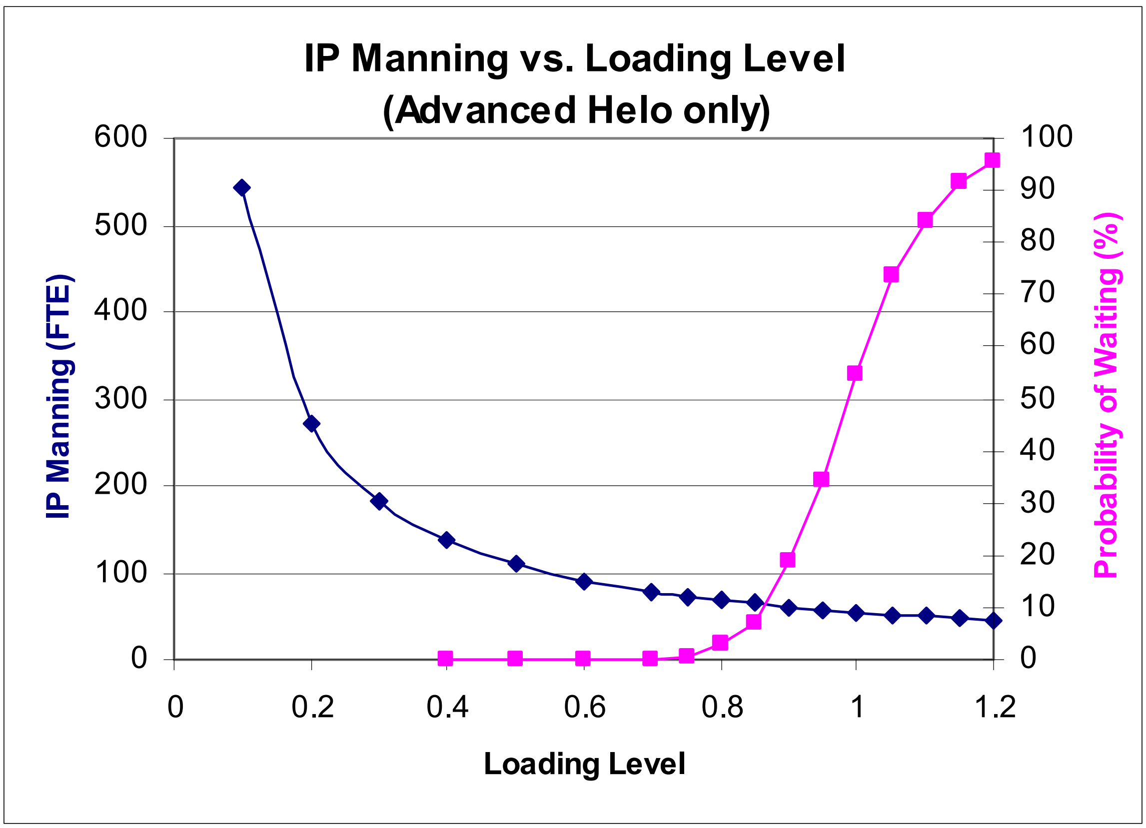

Figure 1: Probability of Waiting and IP Manning versus Loading Level

C. MANNING LEVEL

Is HT-8 manned to the appropriate level now?

Answer: Yes, almost.

As discussed above, a 70% instructor loading level translates to an ideal instructor manning FTE of 77.8. Again, this is based on the FY07 projection of 267 advanced helicopter, 10 Osprey, and 46 Flight Surgeon students. The actual manning level of HT-8 as of February 2007 is 76.25 FTE (CNATRA, 2007). This translates to an actual instructor loading level of approximately 71.4%. The theoretical probability of a student sitting when he should be flying is 0.3%. In other words, HT-8 is almost ideally manned right now to handle their assigned student production for FY07.

D. CRITICAL MANNING LEVEL

At what manning level will HT-8's ability to meet the CNATRA student production goal be at risk?

Answer: - Critical = 68.1 FTE instructors (80% loading level)

- Improbable < 61.2 FTE instructors (89% loading level).

In hindsight, this is somewhat of a vague question. Obviously, this analysis can not account for all factors that affect flight training; however, based on the planning factors available a reasonable estimate can be made. Figures 2 and 3 both show that Training Time (Fly Weeks) and Students Eligible for Flight Events, respectively start to increase dramatically as instructor loading level increases above 80%. An 80% loading level corresponds to 68.1 FTE instructors.

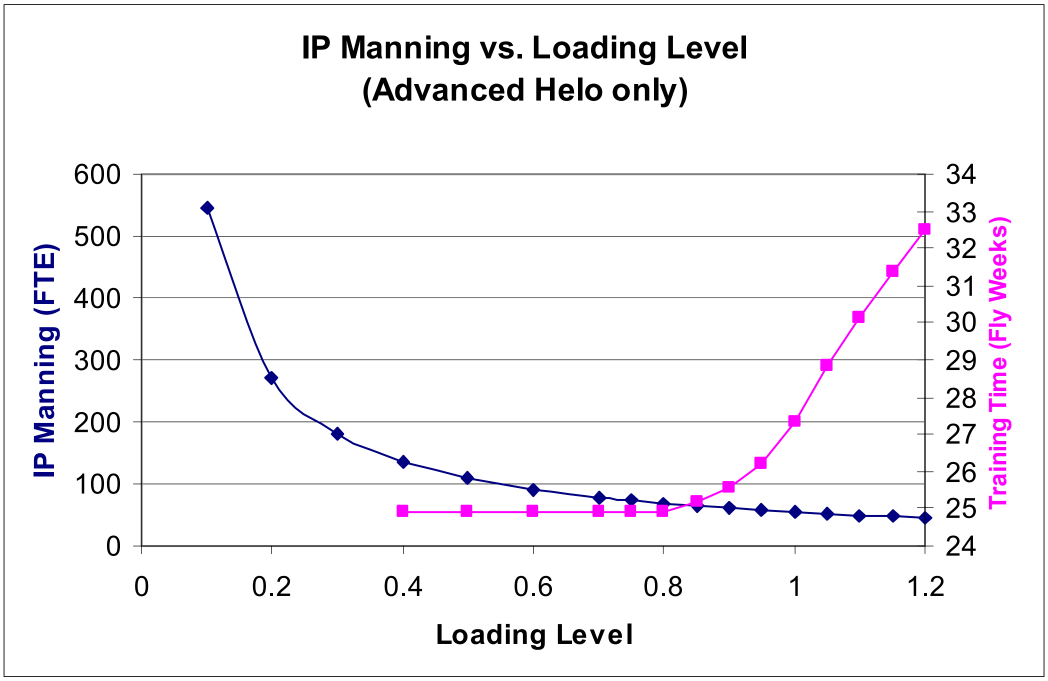

Figure 2: Training Time (Fly Weeks) and IP Manning versus Loading Level

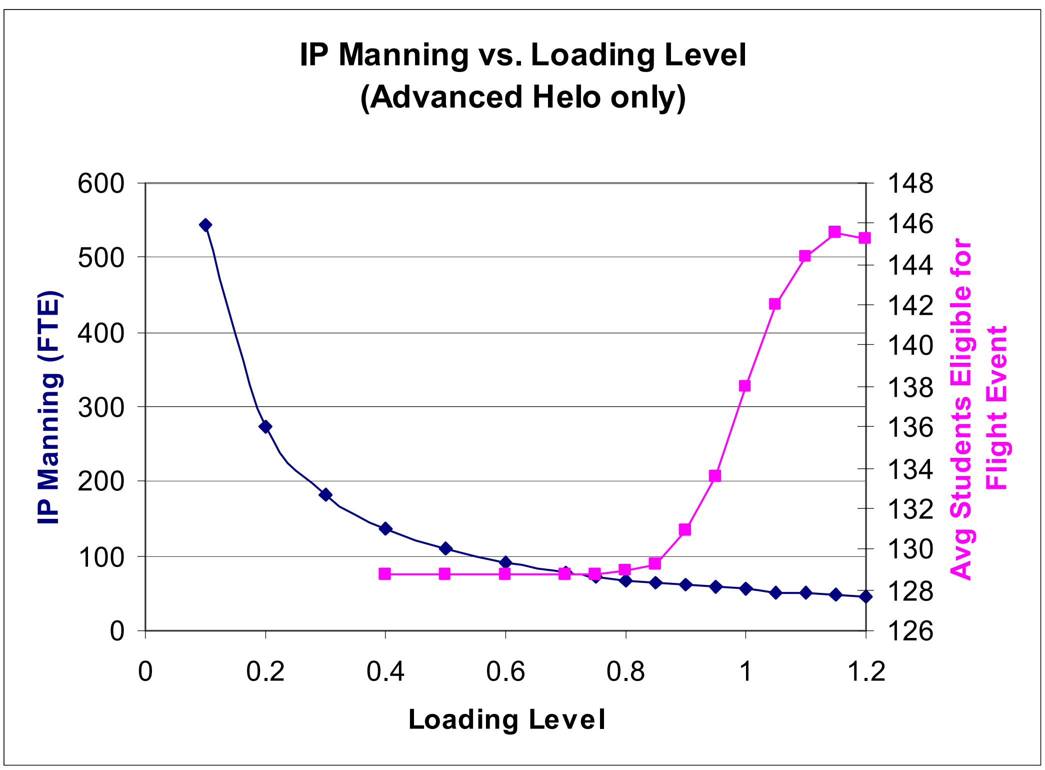

Figure 3: Average Students in HT-8 and IP Manning versus Loading Level

Figure 4 shows a graph of Instructor Pilot (FTE) Manning versus Loading Level on the left axis, with Probability of Blocking shown on the right axis. Mathematically, Probability of Blocking is the probability that there are as many students ready to fly as there are instructors (c) plus students in the waiting pool (K). Realistically, this is the probability that the pool of students waiting to begin flight training starts to increase because there are not enough instructors available to meet the training demand imposed by the incoming students, i.e., the system is literally clogged with students who are otherwise ready to fly. The probability of this scenario occurring begins to increase from zero at 89% instructor loading level (61.2 FTE instructors). Incidentally, the Probability of Waiting at 89% instructor loading level is 30% (Figure 1). This means that approximately 30% of students who are otherwise ready to fly will be sitting because there are not enough instructors available to fly when the student is ready. For this reason, a loading level above 89% (61.2 FTE instructors) makes it improbable for HT-8 to meet its CNATRA student production goals.

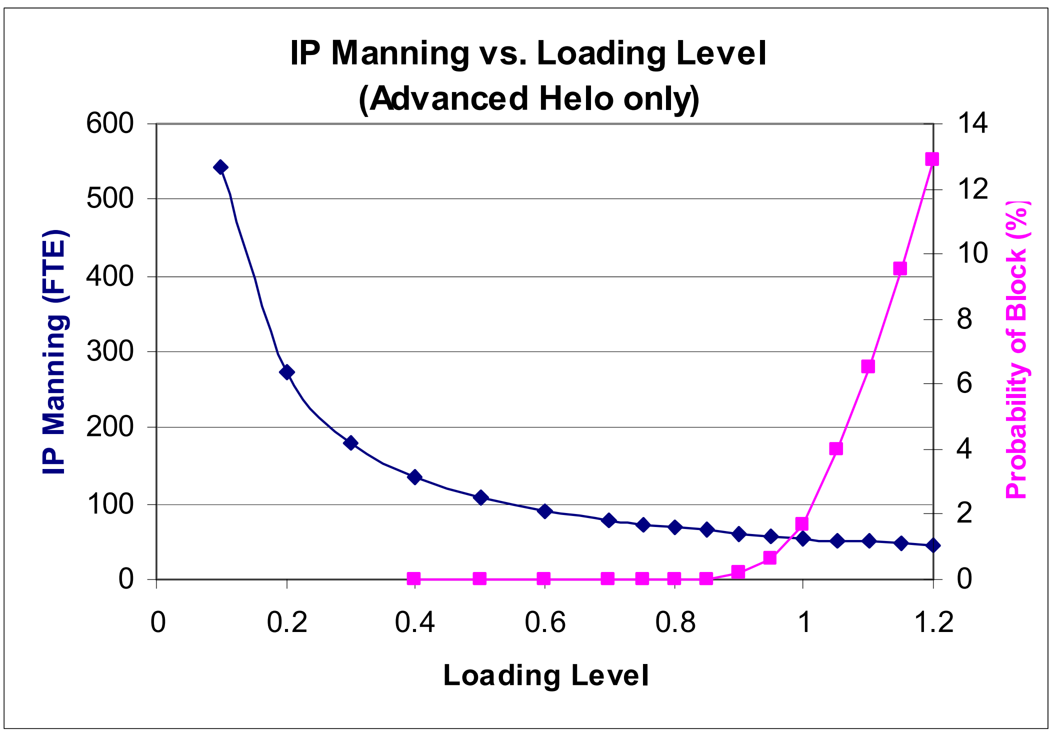

Figure 4: Probability of Block and IP Manning versus Loading Level

E. ANALYSIS VS. REALITY

How do the findings of this analysis compare with the official manning policy for HT-8 (CNATRA manning document)?

The findings of this analysis were generated independent of CNATRA influence and are based primarily on Navy-wide (OPNAVINST 3710) guidance and queuing theory. This analysis is far less complex than the CNATRA manning algorithms, but generates similar numbers, while taking far less time and money to develop. The project basically approached a manning issue from an academic standpoint based on two years of an Executive Masters of Business Administration education, specifically, Operations Management and our own personal experiences as flight instructors working at the ground level.

F. MANNING RATIO

Can a manning ratio (instructors to achievable student production) be developed for executive use in forecasting potential shortfalls if student production requirements are changed unexpectedly?

Answer: Yes.

- Ideal: 70% loading level = 3.45 students/instructors
- Critical: 80% loading level = 3.94 students/instructors
- Improbable: 89% loading level = 4.39 students/instructors

V. RECOMMENDATIONS AND CONCLUSION

A. RECOMMENDATIONS

• Link BUPERS manning levels with forecasted CNATRA Production goals. Recommend BUPERS representative for Instructor Pilot requirements attend semi-annual Production Alignment Conference.

• Research squadron level "bottle necks" or scheduling inefficiencies. While this project accounted for HT-8 as being one link in the chain for pilot production, looking inward to the operations department, scheduling, and individual IP qualifications may add to the overall efficiencies of the entire pilot production chain.

• Consider outsourcing Instructor Training Units (ITU) Instructor Pilots to contract pilots. Currently, training squadrons are required to provide resources (i.e., instructor pilots) for the ITU, which has an impact on available FTE instructor pilots at the squadron level. Outsourcing to civilian contractors to fill the instructor pilots at the ITU may help to alleviate some of the strain on the squadron when they are required to part with FTE instructor pilots.

• Examine MPTS inefficiencies (each student gets a two-hour brief, flight and debrief). The current syllabus defines how the instructor pilot is to manage his training events. Each instructor pilot and student is required to brief and preflight within a two-hour period, fly an event, and then debrief for thirty minutes. One single event takes approximately four to five hours to accomplish. Two events take twice as long. Resolving these inefficiencies would add to the overall efficiencies of the entire pilot production chain.

B. CONCLUSION

With an operational loading level set to 70%, Table 1 shows the required FTE manning level to be 77.8 or 78 instructor pilots. The result of increasing IPP by 15% without increasing FTE manning levels is HT-8 operating at approximately an 80% loading level. The effect this has on surge capacity is potentially crippling to operations and IPP goals. As seen from the graphs, operating at an 80% or greater loading level reduces the squadron's ability to recover from delays such as weather or mishaps. Specifically, Training Time and Probability of Waiting increase exponentially above 80% loading level.

267 Adv Helo + 10 Osprey + 46 Flight Surgeon					
Loading Level (%)	65%	70%	75%	80%	89%
FTE manning level (Monte Carlo 1,000 runs)	83.8	77.8	72.6	68.1	61.2
Ratio (Student Load/Instructors)	3.20	3.45	3.70	3.94	4.39
Ratio (Instructors/Student Load)	0.312	0.290	0.271	0.254	0.228
307 Adv Helo + 12 Osprey + 46 Flight Surgeon					
FTE manning level (Monte Carlo 1,000 runs)	96.3	89.4	83.4	78.2	70.3
Ratio (Student Load/Instructors)	3.20	3.45	3.70	3.94	4.39
Ratio (Instructors/Student Load)	0.312	0.290	0.270	0.254	0.228

Table 1: Increased Requirement of Pilot Production

APPENDIX A

Multiple directives and natural forces limit an instructor's maximum flight time. This analysis accounts for hard limits imposed on flight time by Naval Regulations (OPNAVINST 3710), airfield closures, estimated weather days, estimated instructor sick days, and estimated instructor ground requirements (i.e., duty, academics). This analysis also accounts for quality of life limitations on flight time, including 30 days leave per instructor per year and estimated convalescent/other leave requirements. Finally, operations analysis studies show that loading a queuing system (i.e., a flight training pipeline) to 100% of its capacity will dramatically impact the system processing time (Anupindi, 1999). As such, the available instructor flight time should not be loaded to 100% of capacity.

This study analyzes instructor manning level based on the number of instructors available to train students. These instructors are called Full Time Equivalent (FTE) instructors. Factors that limit the available time for instruction for certain squadron personnel are not considered. In other words, instructor manning level in the context of this study is not the number of instructors actually assigned to HT-8; it is the number of FTE instructors in HT-8. Consideration of instructor time constraints in ground jobs is left to unit leadership.

Exact data does not exist for several of the considerations listed above (i.e., weather days, sick days, and duty days) for a variety of reasons. First, weather cancellations may only occur for a fraction of a day. The lost training is tracked as lost events, not days. Second, though Operations maintains oversight of instructor schedules, it is not cost beneficial for them to track the number of sick days and duty days an instructor is actually assigned. Thus, an estimate of these days was required for this analysis. A Triangular distribution was used for this estimate. The Triangular distribution provides a reasonable estimation based on observation of the minimum, maximum, and most likely number of days lost for each reason by each instructor.

The following method was used to determine total available fly days per instructor per year.

- 365 days per year
- 104 weekend days
- 30 leave days
- 10 federal holidays
- 4 safety stand downs
- Duty days: Triangular Distribution (10 minimum, 24 expected, 28 maximum)
- Weather days: Triangular Distribution (27.2 minimum, 40.8 expected, 54.3 maximum)
- Sick days: Triangular Distribution (3 minimum, 8 expected, 15 maximum)
- Other days: Triangular Distribution (3 minimum, 8 expected, 15 maximum)

The weekend, leave, federal holidays, and safety stand down days are known no-fly days, and they apply equally to all instructors. Though some instructors do fly on weekends and/or federal holidays without a squadron requirement to do so, all weekend days and federal holidays are considered no-fly days in this analysis because Whiting Field is closed. Also, instructors take different amounts of leave, but for planning purposes, the squadron should assume all instructors take the leave they earn each year. Safety stand downs are mandatory, no-fly training days for all squadron personnel.

The distribution of duty days is based on the assumption that most instructors stand two days per month with some instructors standing slightly more, and others standing considerably less. This monthly requirement equates to approximately 24 days per year per instructor.

The distribution of weather days is based on 137 cloudy days in Pensacola per year (CityRating.com/Weather History, http://www.cityrating.com/cityweather). These days are assumed to be evenly distributed on days that are otherwise available for flying and on known no-fly days (weekends, holidays, safety stand downs, leave); therefore, 81.5 days are cloudy that otherwise would have been available for flying. On cloudy days, a reasonable expectation is that only half of the flight schedule is lost. Worst case,

two-thirds of the flight schedule is lost and best case about one-third is lost. Thus, the minimum, expected, and maximum weather days per year are 27.2, 40.8, and 54.3, respectively.

Sick days and other days are not explicitly tracked by the HT-8 Operations Department. Based on observation, the numbers are assumed to be three days minimum, eight days expected, and fifteen days maximum per instructor for each category.
The variability in weather, duty, sick, and other days was accounted for using 1,000 runs in a Monte Carlo simulation.

APPENDIX B

Instead of accepting the CNATRA estimate for flight hours, the following distributions were used for each event. Units of measure are flight hours per flight event.

Advanced Helicopter	Triangular (1.4 minimum, 1.7 expected, 2.0 maximum)
Osprey	Triangular (1.4 minimum, 1.7 expected, 2.0 maximum)
Flight Surgeon	Triangular (1.2 minimum, 1.6 expected, 2.0 maximum)

The CNATRA student curriculum places a flight hour goal on each student event. Several factors (weather, student ability, airfield congestion) cause instructors to routinely over or under fly the flight hour goal for each event. For this analysis, a Monte Carlo simulation of 1,000 runs was used to estimate a reasonable flight hour total per student while accounting for this variability. The following numbers were generated:

Advanced Helicopter	117.4 flight hours
Osprey	66.5 flight hours
Flight Surgeon	8.0 flight hours

Now, the analysis multiplies the flight hours per student by the number of students required in FY07 (267 Advanced Helicopter, 10 Osprey, 46 Flight Surgeons) to determine a total student flight hour requirement. For Advanced Helicopter, it is 31,345.8 hours per year, for Osprey, it is 665.0 hours per year, and for Flight Surgeons, it is 368.0 hours per year. That totals to 32,378.8 hours per year.

APPENDIX C

A reasonable loading level was determined to be 70% and applied to the available maximum instructor flight hours. Solving for required FTE instructor manning level yields the following formula:

$$\text{FTE} = \frac{\text{Total Student Flight Hour Requirement}}{\text{(Loading Level * Maximum Flight Hours per Instructor)}}$$

The FTE was calculated to be 77.8.

Determining an appropriate Loading Level required some imperfect, but reasonable assumptions about the student production pipeline. First, the pipeline was assumed to be a complex queuing system where servers (instructors) service customers (students) independently. Second, student arrival times to the system and the time they spend in the system are assumed to be independent and exponentially distributed random variables. This is reasonable since most of pilot training is independent effort in the aircraft, but imperfect because parts of flight training require more than one student for continuation (i.e., formation, academic classes, student solos). Third, there are c instructors in the system. Fourth, there is an input buffer (pool) of K students continuously waiting to start flight training. The complex set of equations required to model this system was compiled by Dr. Jan Van Mieghem in an Excel spreadsheet called QUEUMMCK.XLS, available at http://www.prenhall.com/anupindi. An immediate limitation of the assumptions made in this analysis is the fact that each student is serviced multiple times by the available instructors, not only once as the equations assume. This limitation is mitigated by using annual servicing rates to determine time-to-train, probability of waiting, and probability of system blocking, but the total students in the system calculated by this analysis is limited to students in the waiting pool plus the number of instructors available (K + c). This is not accurate since there are about twice as many students in the system as there are instructors available.

To determine loading level, only the largest primary mission of HT-8 was considered: advanced helicopter training. The requirement for HT-8 to train Osprey pilots and Flight Surgeons was ignored for a baseline analysis of instructor loading. The FTE instructors required to man HT-8 at each instructor loading level were found using

the procedure outlined earlier. Once the number of instructors required to achieve each loading level were known, the ramifications of each loading level on the training system could be determined. Numbers used in the QUEUMMCK.XLS spreadsheet were:

- R_i = 267 students per year (mean arrival rate)
- R_p = 5.07 students per year per instructor (mean processing rate)
- T_p = 0.1972 years per student (mean processing time)

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